

ASSESSING THE SEDIMENTS AND ITS CONSEQUENCES**L. Sarkar**Department of Chemistry, Siliguri College,
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sarkarlovely@gmail.com**ABSTRACT**

The study is concerned with the contamination consignment monitoring of sediments regarding wetland water resources at Muchia village of Malda District in West Bengal. The study was carried out during April, August and December of the year 1999 at three particular sampling stations attached to the agricultural fields. It was pragmatically noticed that nearly all of the physico-chemical parameters under experiment like pH, electrical conductivity, phosphate ions content, sulfate ion concentration and chloride ion content in the sediment samples were higher during the month of April as compared to the other months in the same year except the concentration of nitrate ions content. The results of the present study implies about the escalating contamination load affecting sediment abode organisms along with the ecosystem of the water sources. It has been experienced that incessant accretion of organic and inorganic pollutants owing to geochemical mechanisms resulting in toxic effect on sediment dwelling organisms.

Keywords: Sediment, Physico-chemical properties, pH, EC, Ion contents.

Introduction

Presently the aquatic ecosystems are being affected to a great extent by numerous health stresses so as to drastically exhaust biodiversity of the environment. Sediments comprising of significant constituents of aquatic ecosystems provide the environment for an extensive range of living organisms. On introduction of certain matters in the sediments can cause a remarkable danger to the physical condition of living organisms. In the near future for aquatic ecosystems, the thrashing of biodiversity and its effects are envisaged to be larger than terrestrial ecosystems (Sala et al., 2000, p. 1770–1774). Considering natural buffer system along with filtration facilities, sediments may play the role in the material cycles of water sources. Sediments of wetlands, ponds, lakes, rivers are significant chief source of nutrients required for aquatic organisms and effectual estimation of the exposure requires discriminating connection between the allied chemicals and occurrence of the unfavorable effects. According to Abowei and Sikoki, (2005), sediment strata dole out for the benthic macro invertebrates whose metabolic behavior adds to aquatic efficiency as incredibly crucial environment. The major providers in the configuration of sediments are weathering of rocks, manufacturing sewages, farming surplus and anthropogenic actions. Organic components also get decomposed by several

bacterial organisms in the suitable environment of sediments. Essential nutrients are incessantly getting interchanged between overlying water and sediment as stated by Abowei & Sikoki, (2005). Augmentation of suspended materials can affect the turbidity of a water body by decreasing light penetration and shrinking its production. Besides, sediments have a great impact on ecological excellence as a consequence of their eminence or amount or sometimes both (Stronkhorst et al., 2004). Constant accrual of materials causing pollution are attributable to biological and geochemical activities resulting in contamination in sediment dwellers, micro and macro organisms and fishes which further affect endurance, growth, reproduction not only to develop rather worsen the environment of species diversity (Mucha et al., 2003, P. 169–180). Furthermore, elevated level of suspended substances may lead to blockage in the respiratory systems of aquatic organisms. Analysis of sediments is becoming progressively more significant in assessing characteristics of the entire ecosystem of a water source. Investigation of sediments instead of water quality study, replicates the long term eminence condition without concerning current inputs (Hodson, 1986, p. 7–21). Chemical pesticide contented sediments are not suitable for fish culture in most of the cases. The sediments bearing with both suspended particles and precipitated materials

accumulate on the bed of the water sources may cause the appearance or a basin for numerous contaminants, impurities and trace materials of less solubility and small extent of degradability (Biney et al., 1994, p. 134-159). Examination of the organic as well as inorganic chemical contents and corresponding to physical composition of sediment samples endow with the information about the changing environment due to different natural or human created factors. On the basis of the chemical perseverance and physical, chemical, biological and biochemical characteristics of the substrata, pollutants may get preserved in sediments over long periods of time. Thus one can come to the conclusion about the probable sources of contagion in the water bodies. In view of Lokhande et al. (2011), as sediments perform the same as sources of pollutants and as sinks in aquatic bodies, therefore, chemical investigation for depiction of sediments also endows with considerable information about natural and anthropogenic impact on the water systems. Wide observation, examination, investigation, experiments are requisite to evaluate the degree and harshness of sediment contagion. There is a dire need to assess the effects of polluted sediments on water bodies in the environment regarding environmental issues and also to find out apposite corrective measures. The present study has been carried out to examine the physico-chemical characteristics of sediment samples of a definite water source which is contaminated due to waste water open drainage systems in the studied village and fertilizers, pesticides, insecticides used for the cultivation in the attached agricultural fields. It is predictable that experimental data viewed from such studies may assist to execute companionable policies, principles and programmes to measure the level of contamination. The study also suggests that the water excellence of the wet lands under experiment gets unfavourably affected and impaired by the emancipation of household and farming wastes including fertilizers, chemical pesticides, insecticides. The investigation will direct for the impending remedies and other supervisions requisite for improving the water eminence.

Study area

The present study has been carried out at Muchia village of Old Malda Block in Malda district of state West Bengal, India and is located 12 KM towards East from English Bazar, the head quarters of the district. Total population of the village according to Census 2011 is 5241 and where the female Population is 49.1 percent. Literacy rate of village is 61.8 percent though the literacy rate of the female population is 26.9 percent. Jute is the main agricultural product of this village. Along with this, paddy, wheat, cereals, several vegetables are also grown in this area during pre monsoon, monsoon and post monsoon seasons. Various organic and inorganic manures in terms of fertilizers, organic and chemical pesticides, insecticides are used for the cultivation. For drinking water purpose, unprocessed tap water is supplied throughout the year in few areas of the village otherwise water from boreholes and tube wells is also used as drinking water sources. They use fishes of nearby ponds, wetlands, rivers located in the farm land areas. Through open drainage system available, drain water gets discharged directly into the nearby water bodies.

Materials and Methods

The reagents and chemical compounds required for the chemical investigation were of analytical reagent grade. For calculating different physico-chemical parameters, chemical experiments were carried out in the laboratory. The required glass apparatus were drenched in nitric acid (HNO₃) prior to every analysis and then cleaned methodically using tap water and distilled water to make sure any trace of foreign elements get detached from the apparatus. After drying properly, the apparatus were used for the experiments. The sediments were collected in the morning session from particular selected sampling stations. Hand shoving plastic core tube of approximately 6 cm diameter was used to collect the sediment samples from the water bodies. Sediment samples were collected from around 15 cm deeper segment from the baseline of the water source. The samples were reserved in cool ice thermocol boxes for the duration of the transportation to the chemical laboratory (Al-Shiwafi, 2005, p. 590-598). After through drying the samples were ground physically to

fine particles in a mortar made of alumina and a 2 mm mesh screen was used to pass the fine particles for further analysis.

Study of Physico-chemical Parameters

This present study represents a meticulous depiction of the physico-chemical characteristics of sediment samples which were collected from particular sampling stations attached to the agricultural fields and the sampling sites were about 200 to 400 meters apart from each others. The sediment samples were analyzed for the following parameters; pH, electrical conductivity (EC), nitrate ions, phosphate ions, quantity of sulphate ions and chloride ions content. The standard techniques were followed as mentioned by APHA, AWWA and WEF; Jackson for the analysis of physical and chemical parameters of sediment samples (APHA, AWWA and WEF, 1998; Jackson, 1973). To avoid any contamination, sealed polythene bags containing the sediment samples were used for transportation. All the apparatus were calibrated first before using for the experiments.

Results and Discussion

The results of the chemical analysis of the physico-chemical parameters of sediment samples are presented in Tables 1. By measuring pH the acidic nature and basic nature of water can be evaluated very easily. This parameter is exceptionally imperative as because a slight change on the value can have a great impact on all the chemical, biological and physical mechanisms as majority of the chemical mechanisms occur in aquatic atmosphere are managed by a particular range of pH. Living organisms in any aquatic systems are susceptible to pH changes. Water bearing with pH around 10 may cause contagion by strong base like components as for example calcium hydroxide or sodium hydroxide (Langmuir, 1997). The pH values in the present study were in the range of 5.7 to 7.8. In the month of August the pH value of sediment samples was observed to be the smallest for all the experimental sites which can also be compared by the graphical representation in the figure 1, 3 and 5. Utmost values of pH 7.8, 6.5 and 7.7 of the three sampling stations respectively, were recorded

in the month of April, during the pre monsoon season. Month wise variation of the pH values can also be observed for all the experimental sediment samples. This may be because of leaching process resulting in deposition of maximum quantity of mineral deposits in terms of chemical fertilizers, domestic effluents and agricultural wastes. The deposited components in the sediments can hold a large amount of calcareous resources like carbonates of calcium and magnesium which on hydrolysis liberate hydroxide anions that may lead to the basic characteristics of sediment samples having higher value of pH.

Electrical conductivity is a very important physico-chemical parameter that signifies the quantity of dissolved solids. Mineralization of a water body can easily be determined by the measurement of conductivity. It includes soluble salts present in sediment samples. On exceeding the electrical conductivity range, germination process of more or less all crops is gravely affected and production of crops gets decreased (Singaravel and Govindamsamy, 2000, p. 24-27). Wagh et al., (2013) depicted that elevated range of electrical conductivity may be because of surplus quantity of soluble salts due to the excess use of chemical fertilizers based on phosphate and potash.

In the present study, the uppermost value of electrical conductivity was recorded 6.724 $\mu\text{mho/cm}$ for site 1 in the month of April whereas the minimum value 4.110 $\mu\text{mho/cm}$ was recorded for site 3 in the month of August that have been tabulated in Table 1 and the month wise variation of the data can be analyzed through figure 1, 3 and 5. It is clearer about the deviation of the values from the table 1. In August due to rain, water of the sample stations gets diluted to a greater extent leading to a decline in the electrical conductance value of sediments under experiment. Whereas higher values of electrical conductivity were supposed to be due to frequent use of fertilizers, pesticides and household wastes etc. Nitrates are compounds of nitrogen and are imperative nutrient for the growth, reproduction process and endurance of living organisms (Agarwal et al., 2000, p. 491-494). High level of nitrates is not apposite for aquatic existence. In case of anoxic atmospheres, nitrate concentration provides as an energy

affluent electron acceptor for different microbial mechanism and after total degradation of these components either dinitrogen or ammonia gets generated. Mineralisation, dry weather, loss of nitrogen in terms of ammonia is quite responsible for the nitrate levels. In this present study, the nitrate range varied from 1.025 mg/l to 2.813 mg/l which can be observed in table 1 and figure 1, 3 and 5 also. The nitrate levels vary with organic matter content in the water bodies. High level of nitrate may lead to eutrophication resulting in flourishing of obnoxious algae along with diminution of dissolved oxygen content by means of reducing the water quality index. As because, formation of nitrate ions are natural occurrence, the mechanism of these anions in the body systems when consumed, there is a requirement to aware of the probable hazards associated with excess amount of nitrate ions.

Open drainage systems and techniques like outwash process may be the reason of transferring the phosphorus elements from the earthly environment to the aquatic segments of the ecological units where an accretion is possible in the sediments of the water sources. According to the environment protection rules (1986), the acceptable limit of phosphate contaminants is 5 mg/l for inland surface water. Phosphorus effluence may cause massive development of the Blue-Green Algae that generates toxic elements which may harm aquatic ecosystems and as a whole water excellence. The level of phosphate in sediment samples was highest 2.98 mg/l for site 2 in the month of August and lowest value 0.93 mg/l was noticed for the site 2 in the month of December. The disparity of the phosphate range can be examined from figure 1, 3, 5. Phosphate level varies with the organic substances that may be washed away from the sediments by the heavy rainfall. Expulsion and consequent sedimentation of suspended matters including nitrogen, phosphorus and household wastes through rain may increase the level of phosphate content in sediments.

The sulfate contamination can be the outcome of extended elevated atmospheric deposition,

fertilizers containing sulphate and possibly the most significant reason at many sites, oxidation of pyrite deposit (Lucassen et al., 2004, p. 249–267). Several dynamic issues that direct the pace of sulphate ions reduction mechanism have not been recognized by means of conviction in the various atmospheric contexts for the reason that numerous factors are drawn in as for example quantity of oxygen, concentration of sulphate ions, temperature, accessibility of organic substances etc. In view of Faust & Osman, (1983) sulphates can impede to the disinfection competence by searching of remaining chloride anions in the distribution system. In this present analysis in the month of April the highest value of sulphate content was 97.7 mg/l for site 3 and lowest concentration 38.23 mg/l was observed in the month of December for site 1 that can also be observed in figure 2, 4 and 6. It was reported that before monsoon, for cultivation of several crops an excess amount of fertilizers, pesticides were introduced to the attached agricultural fields. Due to the frequent use of such chemical effluents the amount of sulphate concentration is higher in the month of April for all the sampling sites.

In wetland water systems, present chloride ions content may affect growth rate and development of plants. Excess chloride anions may cause leaf necrosis, iron chlorosis, flabby roots, root decompose etc. Chloride ion concentration in all the natural water sources varies widely with respect to the surrounding aspects. Plants cannot flourish on water which is chlorinated and as on water unchlorinated; wild animals may suffer from atherosclerosis while taking chlorinated water (Hattersley, 2020, p. 89-95). In the present study, the chloride ion contents in the sediments were observed to be in range of 132 mg/l to 294 mg/l. From figure 2, 4 and 6 the dissimilarities in chloride contents can be observed. The elevated degree of chloride ion concentration also plays a very significant role on the mechanism of phosphorus liberation process from sediments that may result in rigorous tribulations in comparatively pure water systems.

Table 1. Experimental data of physico-chemical properties of three experimental sites

| Site 1 | | | | | | |
|----------|-----|--------------|-----------------|------------------|-----------------|-----------------|
| Month | pH | EC (µmho/cm) | Nitrates (mg/l) | Phosphate (mg/l) | Sulphate (mg/l) | Chloride (mg/l) |
| April | 7.8 | 6.724 | 1.754 | 1.71 | 57.4 | 184 |
| August | 5.9 | 4.215 | 1.224 | 2.35 | 49.54 | 167 |
| December | 7.1 | 5.928 | 2.813 | 1.48 | 38.23 | 132 |
| Site 2 | | | | | | |
| Month | pH | EC (µmho/cm) | Nitrates (mg/l) | Phosphate (mg/l) | Sulphate (mg/l) | Chloride (mg/l) |
| April | 6.5 | 6.216 | 1.025 | 1.44 | 77.4 | 210 |
| August | 6.1 | 5.922 | 0.917 | 1.56 | 68.23 | 202 |
| December | 5.7 | 6.021 | 1.844 | 0.93 | 49.42 | 178 |
| Site 3 | | | | | | |
| Month | pH | EC (µmho/cm) | Nitrates (mg/l) | Phosphate (mg/l) | Sulphate (mg/l) | Chloride (mg/l) |
| April | 7.7 | 5.632 | 1.921 | 1.71 | 97.4 | 294 |
| August | 6.2 | 4.110 | 1.066 | 2.98 | 89.43 | 198 |
| December | 6.8 | 4.324 | 2.101 | 1.69 | 72.93 | 179 |

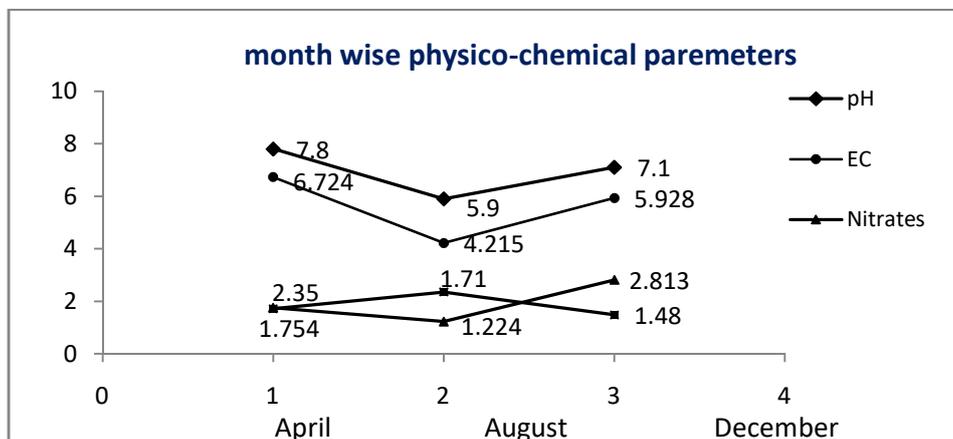


Figure 1. Variation of Ph, EC, Nitrate and Phosphate ions content of site 1

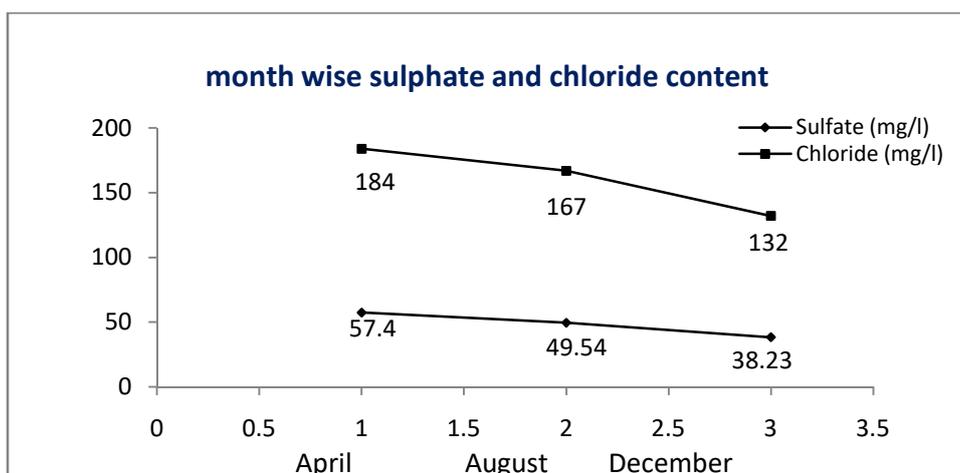


Figure 2. Variation of sulphate and chloride ions content of site 1

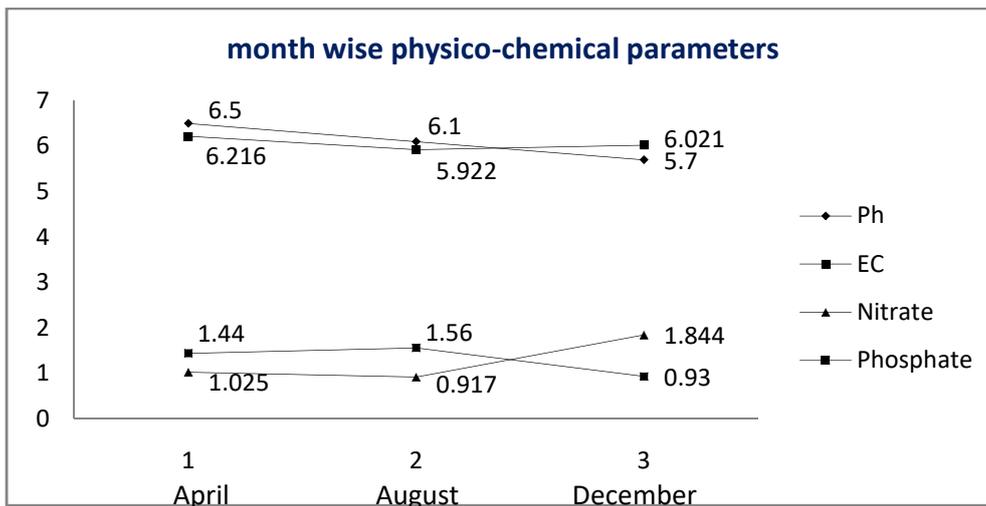


Figure 3. Variation of Ph, EC, Nitrate and Phosphate ions content of site 2

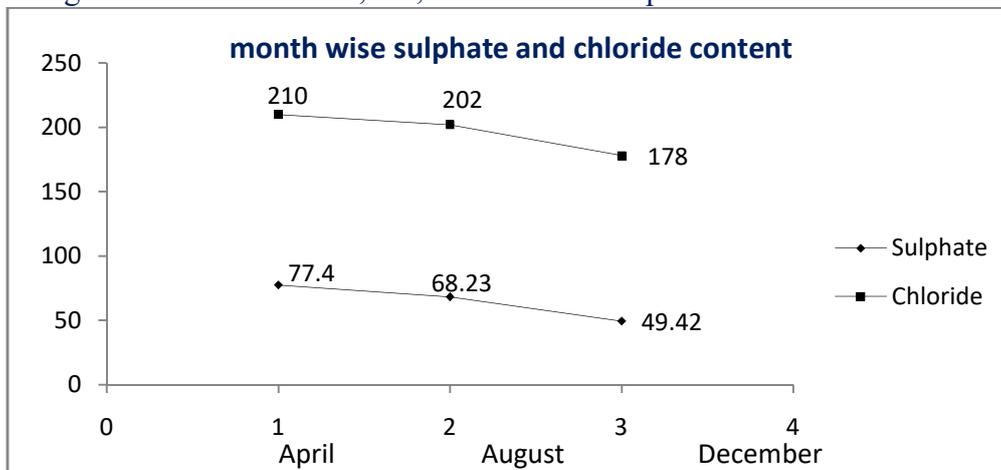


Figure 4. Variation of sulphate and chloride ions content of site 2

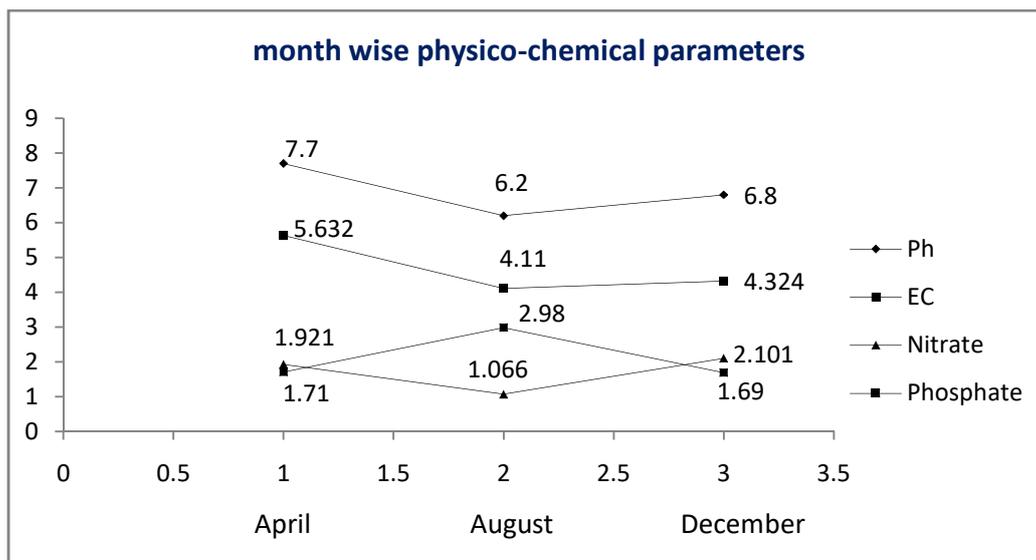


Figure 5. Variation of Ph, EC, Nitrate and Phosphate ions content of site 3

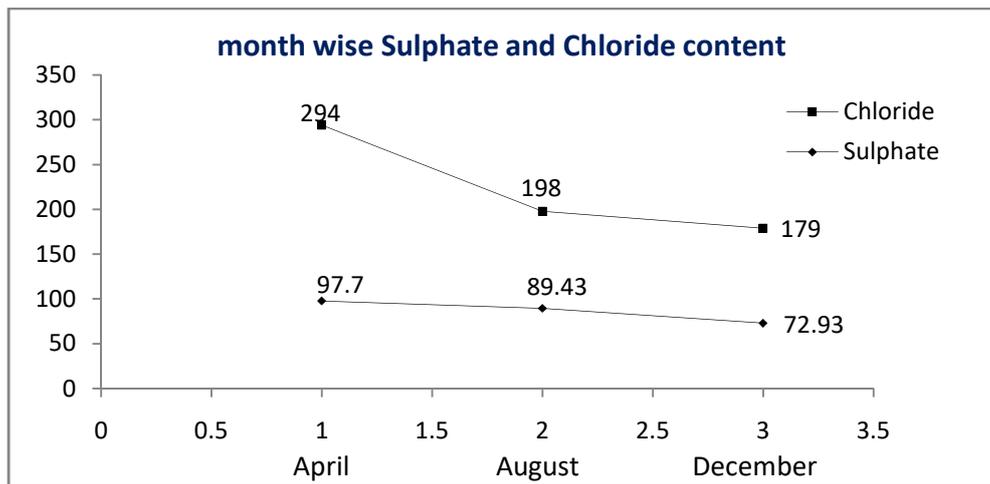


Figure 6. Variation of sulphate and chloride ions content of site 3

Consequences

The contaminants present in sediments have a great impact on human health. Toxic elements may be incorporated in the food web from the polluted sediments. Chemical pesticides along with other chemicals may also affect human reproductive system. Aquatic animals including fish population get contaminated directly due to the contaminated sediments in the water bodies. Pollution of sediments and associated water also harm local animals. In some cases different physical irregularities can be observed in different birds. The direct or indirect environmental impacts are observed due to the contaminated sediments. Various local aquatic habitats are mainly at a high risk for their existence. Quantity and quality of fishes of the water bodies containing toxic sediments are reduced to a greater extent resulting in decrease of fishery resources. Dwellers of the village reported that the quality as well as amount of fishes in the nearby wetlands has got reduced to a greater degree. Regarding human health concern, consumption of aquatic animals of the polluted water generates frequent health problems. Erosion of the soil also gets increased. Wetlands which are the main basis of the ecosystem of the village were getting lost very quickly. Fishery one of the important sources of economy was getting affected very much. Ultimately, the excellence of agricultural fields in terms of soil fertility has got reduced. Contagion of sediments with heavy metals like cadmium, mercury, arsenic, lead etc. can affect the

physiological mechanism of a body system. The unpleasant effects of polluted sediments can cause shrinking inhabitants for the wildlife population as because of reducing prime food resources. It is also predictable that there would be a recurring dissimilarity in the enormity of the studied physico-chemical parameters of the sediments varying with the seasons. Based on the effect of chloride and sulfate, natural purification and filtration of water become no longer possible due to decomposition of organic substances in water.

Conclusion

The experimental results imply to execute certain objectives, companionable guidelines and programmes to filter out the contaminants present in the manufacturing units and household squander water so that the probability of incorporation of pollutants to the agricultural fields, drinking water sources, wetlands become lessen to some extent. In our country if the present circumstances cannot be managed in a proper way, there may be irrevocable environmental destruction. The frequent use of excess fertilizers is one of the most leading processes in integrating contaminants to the sediment samples. Pollutants in sediments can have an effect on the benthic population and all the way through the food sequence; eco toxicological effects may proliferate into the water segments very easily. Several environmental alterations can be evaluated by assessing the sediments quality index that will help to recognize additional features associated with precipitation,

emancipation, shear stress like mechanism. The best prospect to lessen the undesirable effects of sediments would appear when proper sense of awareness will be spawned among the people.

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